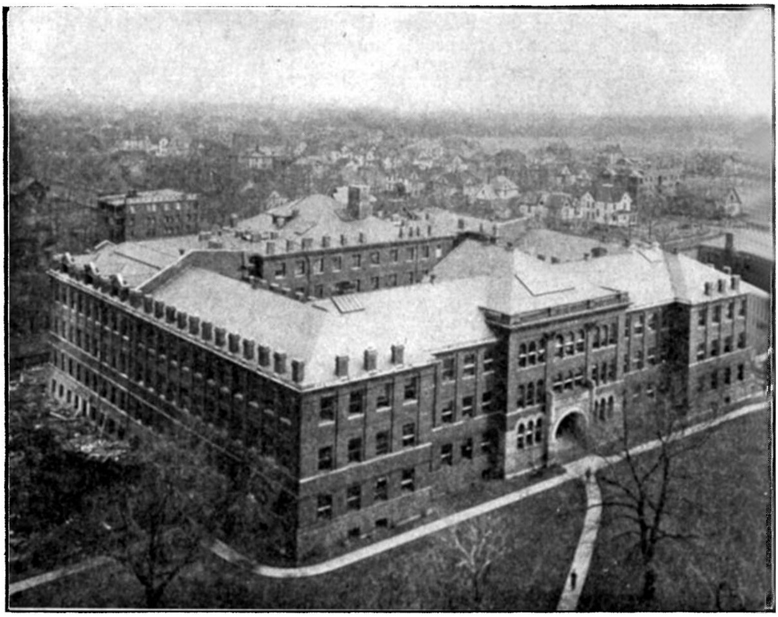

THE CHEMISTRY BUILDING, 1916. View from the tower of University Hall, looking southeast. In the foreground is the old portion of the building; the fire wall separating the new part is shown on both the north and the south portions of the roof.

tions; that leadership must come through systematic and thoughtful scientific research. Progress has been slow because we are just beginning to appreciate the value of research. Many of our institutions of learning are better known for their footwork than for their headwork. Colleges and universities must take the lead in research, for there is no better type of preparedness than research which is effective and persistent.

Upon the opening of the new laboratory, the department of chemistry occupies its fourth home since its organization in 1868. The first quarters were in the basement of the rear wing of the first university building, where heat was supplied from a kitchen stove and water was obtained from a near-by well. In 1878 the department was provided with a separate laboratory, a three-story brick building which is used now as the home of the College of Law. A much larger building was erected in 1902 and this building which is shaped like the letter "E" forms a part of the present completed structure. The present building forms a hollow square, 230 feet by 116 feet, the main lecture room and the machinery for ventilation being in the court. The working space comprises 3.77 acres. Each laboratory is distinctive in that its arrangement and equipment are planned for its own peculiar type of work. Abundant provision is made for research in various lines of work. The present valuation of the entire plant, including equipment and supplies is about $540,000.

THE HYPOTHESIS OF AVOGADRO

THE molecular hypothesis of Avogadro was proposed in 1811. Eight years before, John Dalton had put forward the atomic hypothesis, which bears his name, to account for the laws of definite and multiple proportions and the law of combining numbers. According to this hypothesis, an atom is the smallest particle of an element

which can enter into or be expelled from chemical combination. If the attempt is made, however, to determine the "smallest combining weight" of an atom, the theory shows itself to be defective in that it lacks a standard for fixing the atomic weights of the different elements. In 1808 J. F. Gay-Lussac had observed that when two gases react chemically, the volumes which react bear a simple ratio to one another and to the volume of the gaseous product of the reaction. It follows at once if elements in a gaseous state unite in simple proportions by volume, and if the elements also unite in simple proportions by atoms, then the number of atoms in equal volumes of the reacting gases (at the same temperature and pressure) must be simply related. But even so, we still have no means of determining the numerical value of this relation, and therefore can not use the discovery of Gay-Lussac as such to determine relative atomic weights.

Avogadro (1811) went one step further in suggesting that this volume relation pointed out by Gay Lussac is the simplest possible, viz., *equal volumes of all gases, at the same temperature and pressure, contain the same number of ultimate parts, i. e., molecules.* A distinction is made between the elementary atoms and the small particles of a gas. Assuming that the small particles of a gas are aggregates of a definite number of atoms, Avogadro called these aggregates molecules, to distinguish them from the ultimate atoms. Avogadro thus modified the atomic hypothesis and adapted it particularly to gases. The hypothesis of Avogadro has been confirmed by such an abundance of subsequent work that it is now placed among the well-established laws of chemistry and physics. The same hypothesis was announced independently by the French physicist Ampère in 1814. By Avogadro's hypothesis equal volumes of gases contain the same number of molecules, consequently, the relative density of a gas is proportional to its molecular weight. The determination of the relative molecular weight of a gas is thus reduced to a laboratory measurement—the determination of the relative density of the gas.

After the proposal of Avogadro's hypothesis efforts were made to work out a reliable system of atomic weights; but chemists persisted in using and abusing the terms, "atomic weight," "combining weight" and "molecular weight" in every conceivable way, with the result that rank confusion prevailed in chemical literature. The confusion was increased by the attempt of Avogadro to apply the hypothesis to substances which could not be vaporized. This state of affairs led ultimately (1840) to the abandonment of the hypothesis by most chemists. Only Avogadro and Gaudin accepted it but without furnishing further evidence.

In the forties, however, a new epoch was begun in the history of Avogadro's theory, when Gerhardt recognized its value for the determination of formulas. Among the first to adopt the views of Gerhardt was Laurent, and these two men worked together earnestly for a period of about ten years, with the result that more and more attention was given to their views. At the death of these men in the early fifties, the work devolved upon the younger chemists—Cannizzaro and Kekulé. It was Cannizzaro who finally (1860) cleared up the confusion by showing just how the molecular hypothesis could be used to solve the problem of the relative weights of the atoms. Cannizzaro pointed out very distinctly the difference between atoms and molecules—"equal volumes of gases, whether they be simple or complex, contain an equal number of molecules, but not an equal number of atoms"—and proved that the molecular hypothesis was in harmony with all known facts. In addition, Cannizzaro called attention to the fact that Avogadro was the first to suggest this hypothesis. At the Congress of Chem-

ists at Carlsruhe in 1860, due largely to the initiative of Kekulé, Cannizzaro played a leading rôle. Lothar Meyer said (1860) after reading Cannizzaro's pamphlet, "the scales fell from my eyes, my doubts disappeared, and a feeling of tranquil security took their place." And while the hypothesis of Avogadro still remained a subject of controversy for some years, the day was won.

THE AVOGADRO MEDAL AND THE WORK OF PROFESSOR MORSE

In 1911 an international congress of scientists met in Turin, where Avogadro was formerly a professor in the university, for the purpose of celebrating the hundredth anniversary of the famous "Hypothesis" and of honoring the memory of its author. Out of the funds contributed for the occasion 1,500 Lire were set aside for an "Avogadro Medal" to be awarded, during the year 1915 or soon thereafter, by the Academy of Sciences of Turin, to the one who in its judgment should have published during the three-year period, 1912–1913–1914, the most notable contribution (experimental or theoretical) in the domain of molecular physics. It was this medal which was awarded at a meeting of all the sections of the Accademia Delle Scienze Di Torino on February 6, 1916, to Professor H. N. Morse, of the Johns Hopkins University, for his work upon "The Osmotic Pressure of Aqueous Solutions." This investigation was begun, after considerable tentative study of the problems to be solved, about 1899, and it has since been carried out under the auspices of the Carnegie Institution of Washington. A report on the progress of the first fourteen years of the work is given in Publication 198 of the Institution.

It is impossible to give in the space available any adequate outline of the investigation of Professor Morse and his co-workers, Drs. Frazer and Holland; but a few brief statements may be useful by way of orientation. In 1877, W. Pfeffer, then professor of botany at Basel, published under the title "Osmotische Untersuchungen" an account of his endeavors to measure osmotic pressure by means of porous cells lined with a "semi-permeable" membrane consisting of potassium ferrocyanide. The phenomena described by Pfeffer were impressive, and his quantitative results were accepted as at least approximately correct. He attempted the measurement of very moderate pressures only, and the concentration of his solutions was given in percentages. No one seems to have concerned himself about the *molecular* concentration of Pfeffer's solutions until 1887 when Van 't Hoff published his epoch-making conclusions regarding the analogy between gas pressure and the osmotic pressure of solutions. Van 't Hoff's conclusion that the latter would be found to obey the laws of Boyle and Gay-Lussac for gases was based, in part, on the recalculated results of Pfeffer's experiments. To chemists the way now seemed clear to a satisfactory experimental study of the molecular condition of substances in solution; *for it was only necessary to measure their osmotic pressure, and, apparently, Pfeffer had shown how this could be done.* Probably in nearly every working laboratory in the world attempts were soon made to repeat the experiments of Pfeffer as a preliminary to the investigation of solutions through their osmotic pressure; but every such attempt failed.

All serious attempts to measure osmotic pressure directly were soon abandoned, except by Professor Morse and his co-workers. The reason why all previous investigators (himself included) had failed to attain even to the partial success of Pfeffer, and why Pfeffer himself had not obtained better results, is shown in his chapter on "Membranes." A fundamental condition of success in the direct measurement of osmotic pressure is found to be that the semi-permeable membrane shall